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FACTORS AFFECTING THE CONCENTRATION OF METAL IONS IN MUNICIPAL REFUSE LEACHATE.

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The use of landfill has been the traditional means of disposing of municipal refuse and remains the most economical and attractive disposal option. Despite the long history of this form of disposal, much remains unknown of the processes that occur in the refuse site. The effects of toxic contaminants in municipal refuse is of particular concern since migration of these species to the environment might occur. Factors which affect the migration of contaminants are complex and include: the variable nature of refuse, the infiltration of moisture from precipitation, the microbial breakdown of organic matter, the generation of an anaerobic environment and the temperature fluctuations. One of the major difficulties in assessing the impact of a municipal refuse site on the environment is in predicting the quantity and contaminant levels of the leachate produced.

The leachate generated from a municipal refuse landfill begins as precipitation and undergoes a number of changes as it percolates through the landfill environment. The initial air saturated water becomes increasingly anaerobic and becomes loaded with both inorganic and organic species before seeping into the water table. The impact of this liquid on the

environment is determined by the volume discharged and the concentration of species in the liquid. Predicting the concentrations of metal ions in the leachate is very difficult due to the nature of the refuse and the reactions taking place in the landfill.

One approach in determining the composition of the leachate is to identify the relative importance of the various factors in controlling the amounts of the contaminants. In this work, we studied the concentration constraints that might occur because of the presence of carbonate and hydroxide species. Many metals have sparingly soluble salts of carbonates or hydroxides, so that there might be a natural limit to the concentrations of these species found in municipal refuse leachate.

The assumptions that were used in testing this hypothesis are that the biological breakdown of organic matter to CO_2 cannot produce a pressure of more than one atmosphere (101 kPa). This gas pressure would set the maximum dissolved CO_2 concentration and can be calculated from gas law solubilities. This dissolved CO_2 would equilibrate to form the carbonate and bicarbonate ions (dependent on the pH of the leachate) and in turn limit the concentrations of some of the dissolved metal ion species. This approach assumes that the liquid and solids are in contact sufficiently long to establish a pseudo-equilibrium state. While maximum concentrations of metal ions can be calculated, many additional factors could prevent concentrations from reaching these values. However, concentration values cannot exceed the

solubility limits unless the metal ion is in a complex, more stable than the carbonate/bicarbonate/hydroxide salts. Identification of these very stable metal complexes is particularly important because the complexes are likely to be organic in nature and hence able to be assimilated in the food chain. Thus maximum metal ion concentrations that can be predicted through solubility laws, can be modelled for worst case scenarios, while metal ion concentrations that exceed solubility predictions should be targeted for their impact on the biosphere because of their potential for bioaccumulation.

The metals that have been investigated include: calcium, lead, zinc, iron and cadmium. The data from column studies on the effect of codisposal of industrial wastes with municipal refuse was used as the source of metal ion concentrations as a function of pH. These studies have been reported elsewhere[1]. All the metals studied showed concentrations less than that predicted by solubility modelling except iron. In general, a good correlation with solubilities based on carbonate for pH ranges 5 to 8 was observed, while hydroxide solubilities yielded less accurate predictions. Conversely, for a pH ranging from 9 to 12.5, predicted concentrations based on hydroxide solubilities were closer than those predicted by carbonate solubilities. The formation of stable organic zinc complexes reported by Pohland and Gould[2] were not observed in this work, despite the significant zinc concentrations of industrial waste used in some of the tests.

The iron concentrations observed were interesting because they exceeded

the solubility limits expected for the given pH and carbonate levels. Since all of the samples were from filtered leachate (<0.45um) the possibility of microbial or suspension interference is low. The solubilized iron was sensitive to oxygen which caused precipitation in leachate samples exposed to air. The evidence points to the presence of an organic complex of iron. Since the complex is unstable in the presence of air, the mobility of the species is likely to be limited.

The significance of the research is that a variety of metal ions which are found in municipal refuse leachate appear to be adequately modelled through solubility limitations imposed by carbonate and pH conditions. The presence of an organic iron complex in municipal refuse leachate is an important finding since the concentration limits imposed by carbonate and hydroxide conditions do not apply. This species may have implications for bioaccumulation.

1. Kirk, D.W. and Pirani, S., Report on Codisposal of Municipal and Industrial Wastes, Proceedings: Technology Transfer Conference No. 9, 1988.

2. Pohland.F.G. and Gould, J.P., "Fate of Heavy Metals During Landfill Stabilization of Solid Waste Materials with Leachate Recycle", Final Project Report., EPA Project R-806498, 1984.

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